IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of: Cyril Cabral, Jr.	Filed: 11/21/2003 Examiner: Kiesha L. Rose
Serial No. 10/707,117	Group Art Unit: 2822
Title: Interconnect Structure Diffusion Barrier With High Nitrogen Content	Docket #: FIS920030252US1

DECLARATION UNDER 37 C.F.R. §1.132

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

I, Cyril Cabral, Jr. hereby declare that:

1. I have a degree in Electrical Engineering.

2. I am experienced in the field of semiconductor processing and am very knowledgeable about copper diffusion barriers in semiconductor applications and related processes.

3. Since 1989 I have been employed at IBM in the field of semiconductor processing.

4. I have read and understood the above-referenced patent application and its prosecution in the U.S. Patent and Trademark Office.

5. I have read and understood the Nogami, Werkhoven and Chen references cited by the Examiner in the prosecution of the referenced patent application.

6. In modern IC semiconductor processing, the barrier layers for copper interconnections must withstand high temperature processing of subsequent integration steps.

7. Contemporary practice in fabricating ICs is that the failure temperature must be as high as possible, preferably exceeding 730 degrees Centigrade.

8. I have not found any statement in the references cited above that their barrier layers have a failure temperature above 730 degrees Centigrade. The barrier layers taught by the references may or may not hold up to subsequent semiconductor processing , but there is no indication to one skilled in the art that they would work.

9. The prior art cited in the present specification (U.S. Patent 6,117,769 to Nogami et al.) does not teach or suggest a failure temperature for any thickness of barrier layer.

10. Applicants' prior art (Nogami) teaches that nitrogen is present in a range of 85 - 90 at % for the mixture of tantalum nitride species that they used (and 67 at% for TaN_2). Therefore, the smallest value of x in TaN_x is 2 (equivalent to TaN_2) and the preferred range is 5.5 to 9, equivalent to 85 - 90 at %.

11. The Werkhoven reference does not teach any particular value for x in TaN_x.

12. The Chen reference does not specify a particular thickness for a sufficiently strong liner to support a weak dielectric. The example illustrated starting on line 55 of Col. 17 does not indicate to one skilled in the art that a barrier layer thickness of 0.5nm would provide significant mechanical stability to a low K dielectric. The example describes the entire range of parameters, not merely the one feature of mechanical stability. Mechanical stability increases as the thickness increases, so one skilled in the art would realize that a thickness to provide significant support would be in the high end of the thickness range in the cited passage in Chen.

13. The resistivity of a material does not depend on its thickness, but is a property of the material and its temperature.

14. The Chen reference does not teach or suggest, inherently or otherwise, that the barrier material has any particular value of resistivity. In particular, the Examiner's statement in the last sentence of the second full paragraph of page 4 of the Action that: "since it is stated in [sic] the resistivity is determinate on the thickness of the liner material and since the liner material is 0.5nm (which is claimed) then the resistivity of the liner would be greater than 1000 micro-Ohm-cm" does not make sense. Applicants' specification does not state that the resistivity depends on the thickness. Rather, Applicants state, and one skilled in the art would understand, that the <u>failure temperature</u> has been measured as a function of thickness. Further, as the thickness of the barrier declines to 0.5nm, the resistivity of the material does not decline, but the failure temperature does decline. Fig. 4 shows that the failure temperature of a prior

art material such as Chen's is unacceptable for a barrier material thickness of less than 4nm.

15. The Chen reference does not teach a barrier having a failure temperature above 730 degrees C for a thickness of less than 4nm.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were wade with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the above-identified application or any patent issued thereon.

by: Cyril Cabral, Jr.
Cyril Cabral, Jr.

Dated: 10/12/05